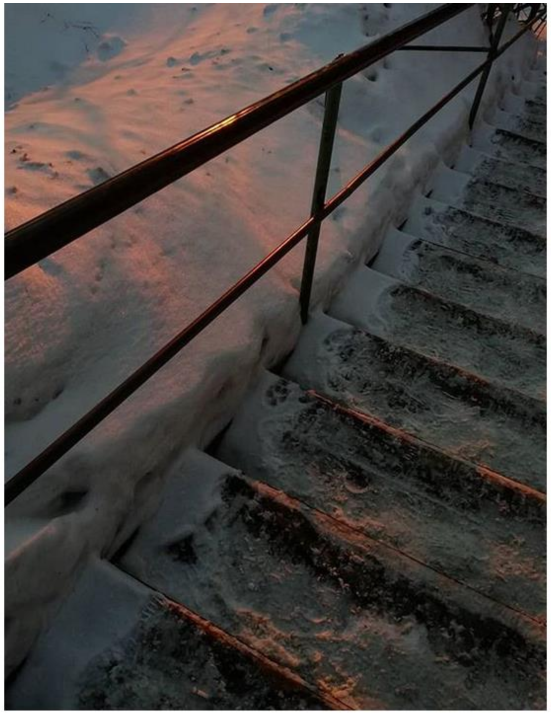
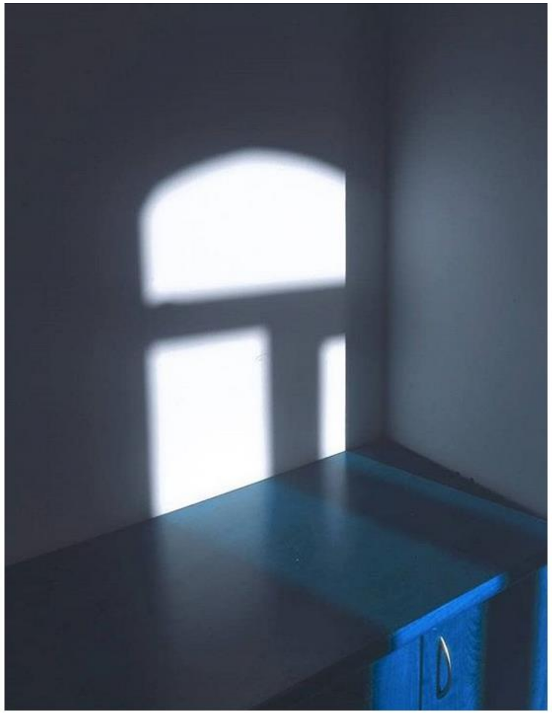
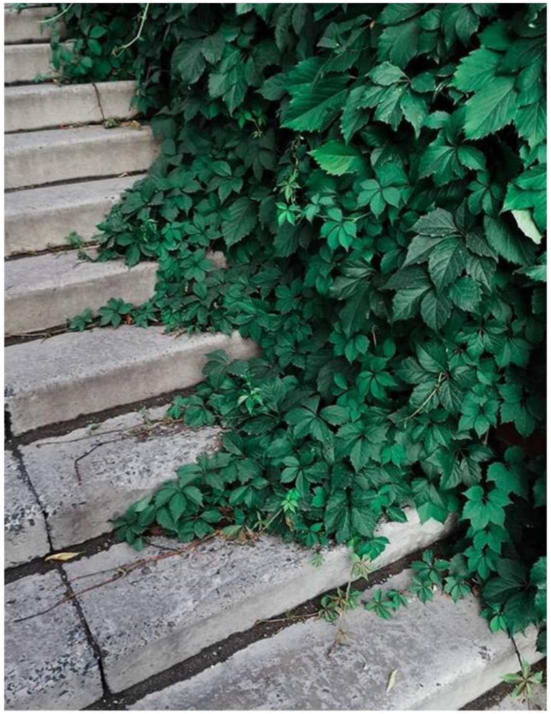
First draft // July 18, 2025





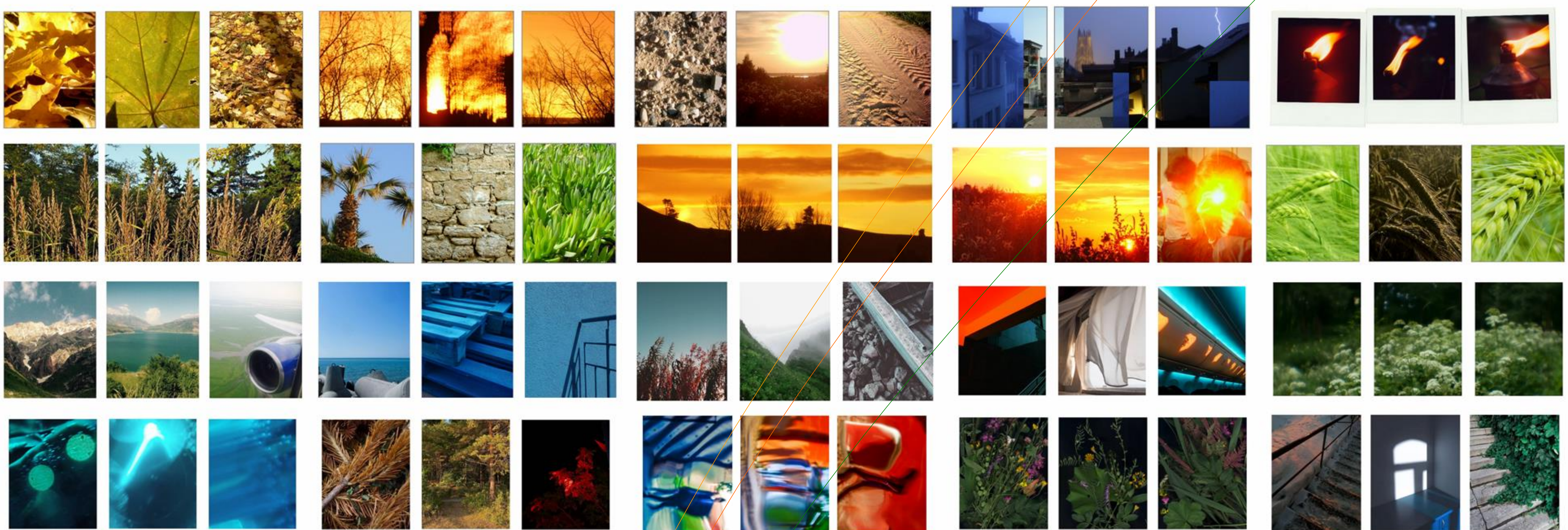


Preparation to the Young Physicists' Tournaments' 2026

Ilya Martchenko,[1 *] Nikita Chernikov,[2] Aleksandr Zinkevich,[2] and Anastasiya Litvinova[2]

[1] Foundation for Youth Tournaments; [2] Novosibirsk State University

20 years with the Reference Kit



- Over ½ of all IYPTs 1988...2026 (20 out of 39)
- 340 problems for PFs (out of 663+6)
- An amazing team of co-authors (since 2012)
- A successful case of knowledge transfer
- A tool to increase visibility and promote IYPT problems towards participants and a broader community
- A visible cooperation-based asset of the IYPT portfolio
- A model for excellent follow-up efforts

The Day One was September 29, 2006

Is the novel research limited and discouraged by the existing common knowledge and the ongoing work of competing groups? :-)

Important information

- The basic goal of this Kit is not in providing students with a start-to-finish manual or in limiting their creativity, but in encouraging them to
  - regard their work critically,
  - look deeper,
  - have a better background knowledge,
  - be skeptical in embedding their projects into the standards of professional research,
  - and, as of a first priority, be attentive in not “re-inventing the wheel”
- An early exposure to the culture of scientific citations, and developing a responsible attitude toward making own work truly novel and original, is assumed to be a helpful learning experience in developing necessary standards and attitudes
- Good examples are known when the Kit has been used as a concise supporting material for jurors and the external community; the benefits were in having the common knowledge structured and better visible
- Even if linked from iypt.org, this file is not an official, binding release of the IYPT, and should under no circumstances be considered as a collection of authoritative “musts” or “instructions” for whatever competition
- All suggestions, feedback, and criticism about the Kit are warmly appreciated

Problem No. 1 “Invent Yourself”

A self-starting siphon can be made using a piece of rigid tubing bent into a specific shape. When the siphon is partially immersed in water, it begins siphoning water without the need for initial suction. Investigate how the relevant parameters, such as the geometry, affect the siphoning process.

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- This Tube Makes Water Flow By Itself (youtube, The Action Lab, 04.08.2023), https://youtu.be/nA_ZTkLYNtA
- Эксперимент "Сифон" (youtube, Андрей Ерошкин, 07.01.2021), https://youtu.be/1lmQVxB3F2Q
- I MADE THE BIGGEST SELF STARTING SIPHON (youtube, President Chay, 13.10.2020), https://youtu.be/lnbhVUG2Hog
- Make a Self-Starting Siphon | STEM Activity (youtube, Science Buddies, 08.05.2020), https://youtu.be/SjNR8mQKDqo
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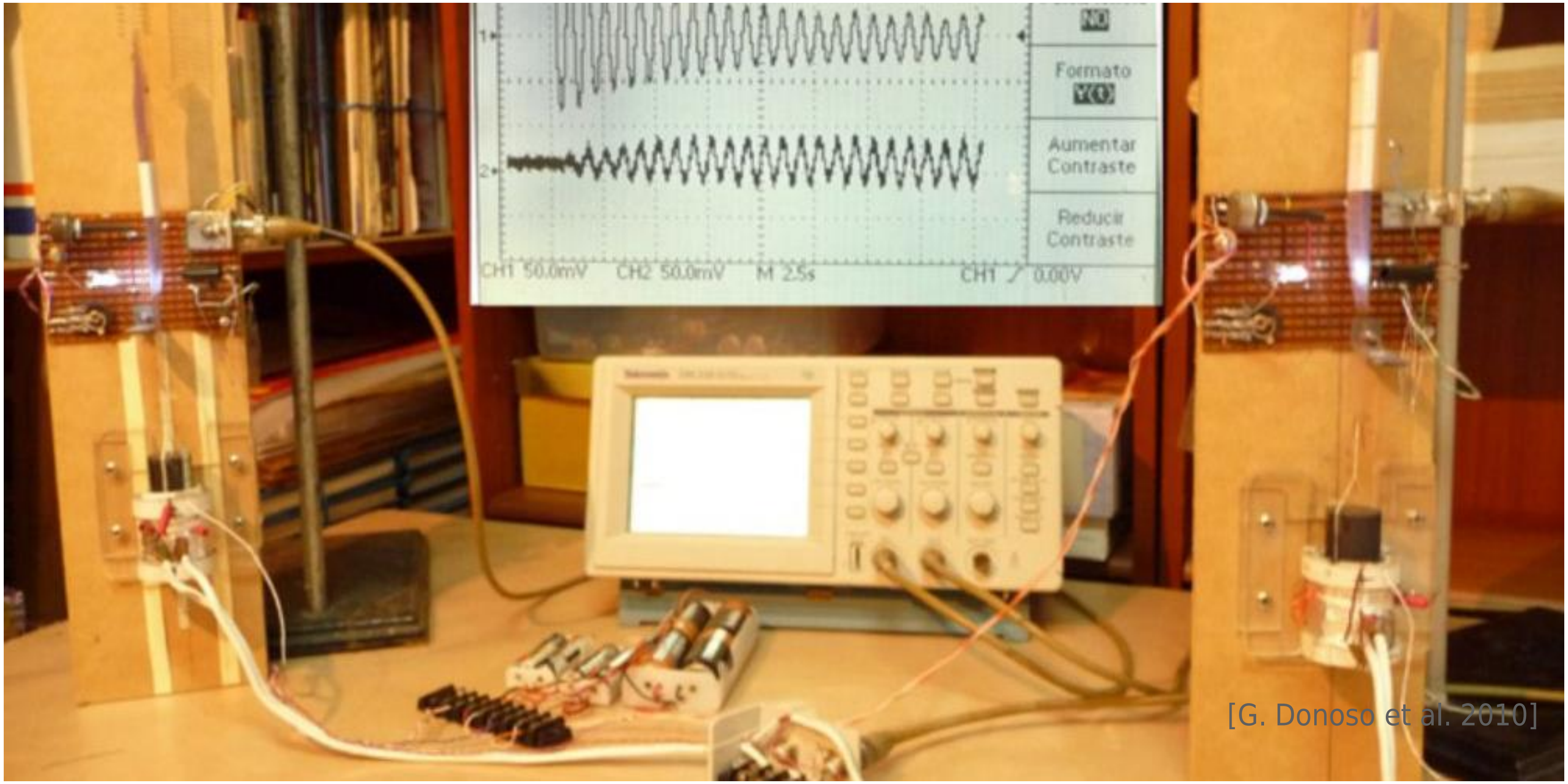
- Make a Self-Starting Siphon (Ben Finio, Science Buddies), https://www.sciencebuddies.org/stem-activities/self-starting-siphon
- 52.5: The Siphon (phys.libretexts.org), https://phys.libretexts.org/Courses/Prince_Georges_Community_College/General_Physics_I:_Classical_Mechanics/52:_Fluid_Dynamics/52.05:_The_Siphon



[G. Donoso et al. 2010]

Problem No. 2 “Electrical damping”

A magnet suspended by a spring will display simple harmonic motion when displaced. If the magnet oscillates within a coil connected to a resistor, its motion will be damped. Investigate the factors that affect the damping.

Background reading

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Problem No. 3 “Ring fountain”

When a flat metal ring falls from a certain height into a water tank, it generates a fountain that can shoot water high into the air. How does the maximum height of the fountain depend on the ring's parameters?

Background reading

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- Кумулятивные струи (youtube, GetAClass - Физика в опытах и экспериментах, 26.12.2023), https://youtu.be/suF5Q2x3-Wk
- Slow-motion Footage of Objects Falling in Water (youtube, Billy Zig, 02.12.2022), https://youtu.be/7KjBRGQGMFg
- Cumulative jets - Experiments in physics (youtube, GetAClass - Физика в опытах и экспериментах, 24.12.2015), https://youtu.be/-GEej63qXGo
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Problem No. 4 “Oil flow”

A thin layer of cooking oil on a flat metal surface flows outwards when heated. Investigate the phenomenon and its dependence on relevant parameters.

Background reading

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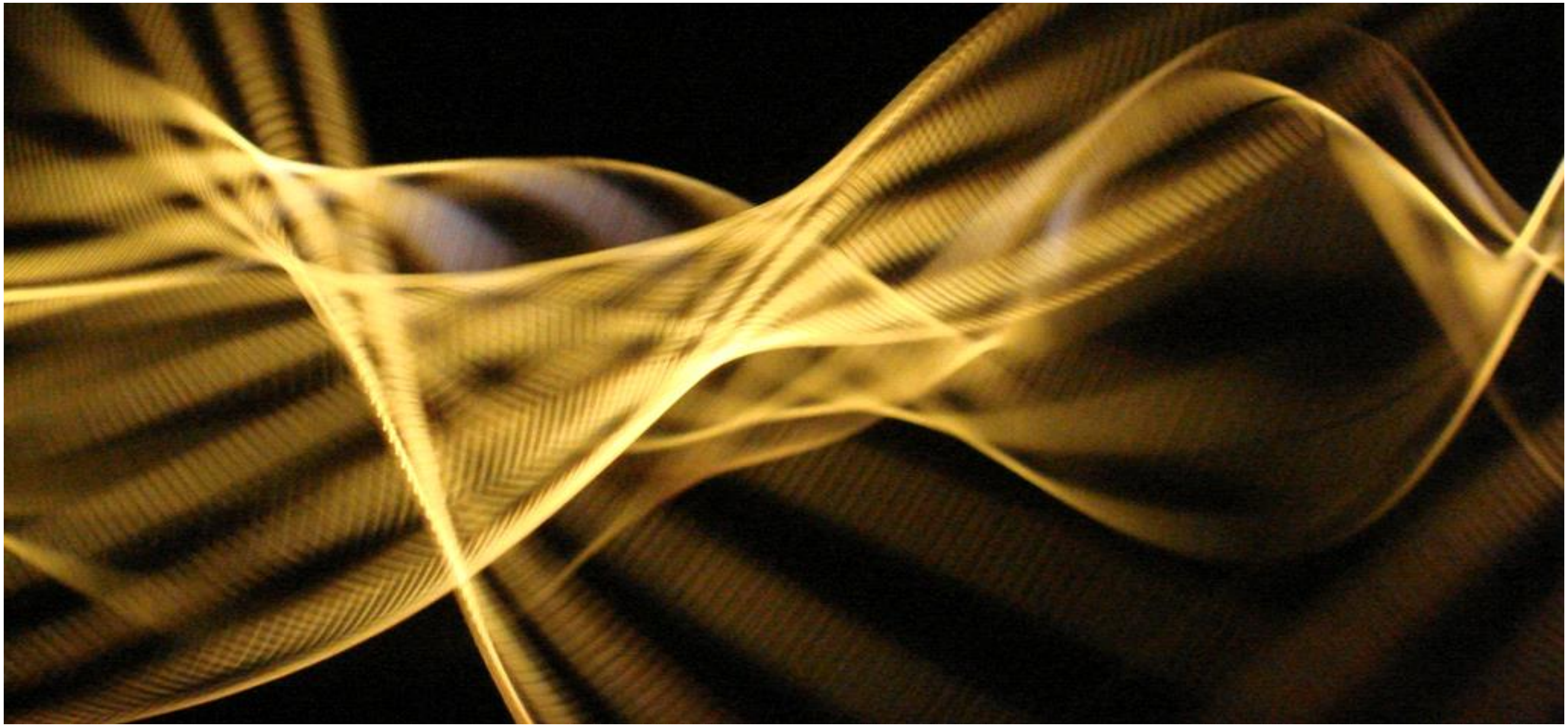

Problem No. 5 “Elastic wave dynamics”

Suspend a metal ball from a fixed support using a rubber band and twist it many times around its vertical axis. When the ball is released, standing waves are formed on the rubber band. Investigate this phenomenon and study how the wave depends on relevant parameters.

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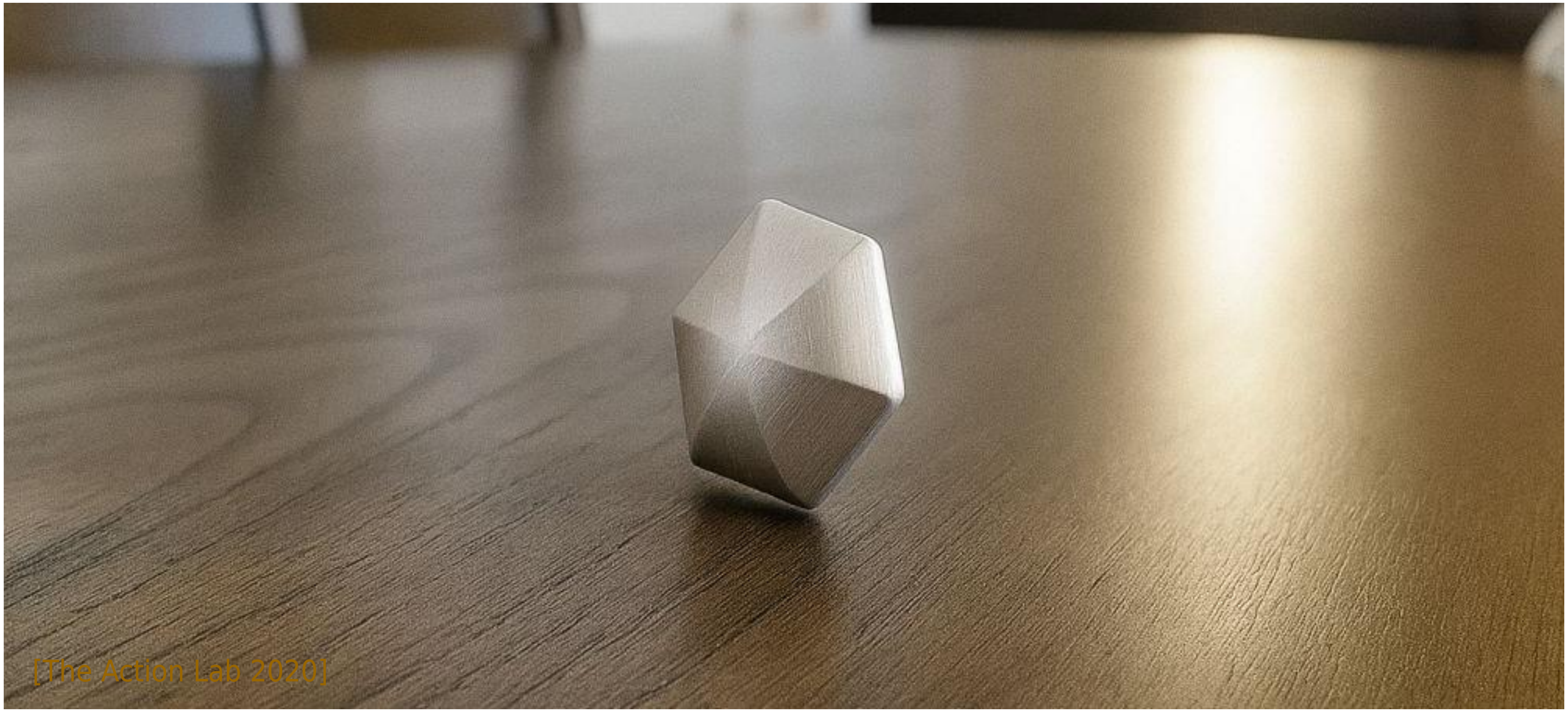
[The Action Lab 2020]

Problem No. 6 “Flipo Flip”

A Flipo Flip toy can roll for multiple turns even though its shape is not circular. Investigate how its motion depends on parameters such as geometry and the initial release conditions.

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Problem No. 7 “Tennis racket theorem”

When an object with different principal moments of inertia about each axis is thrown while it rotates, it can suddenly start rotating around an axis different from the one it was initially rotating about. Investigate how the rotational motion of such an object is affected by relevant parameters during its free fall.

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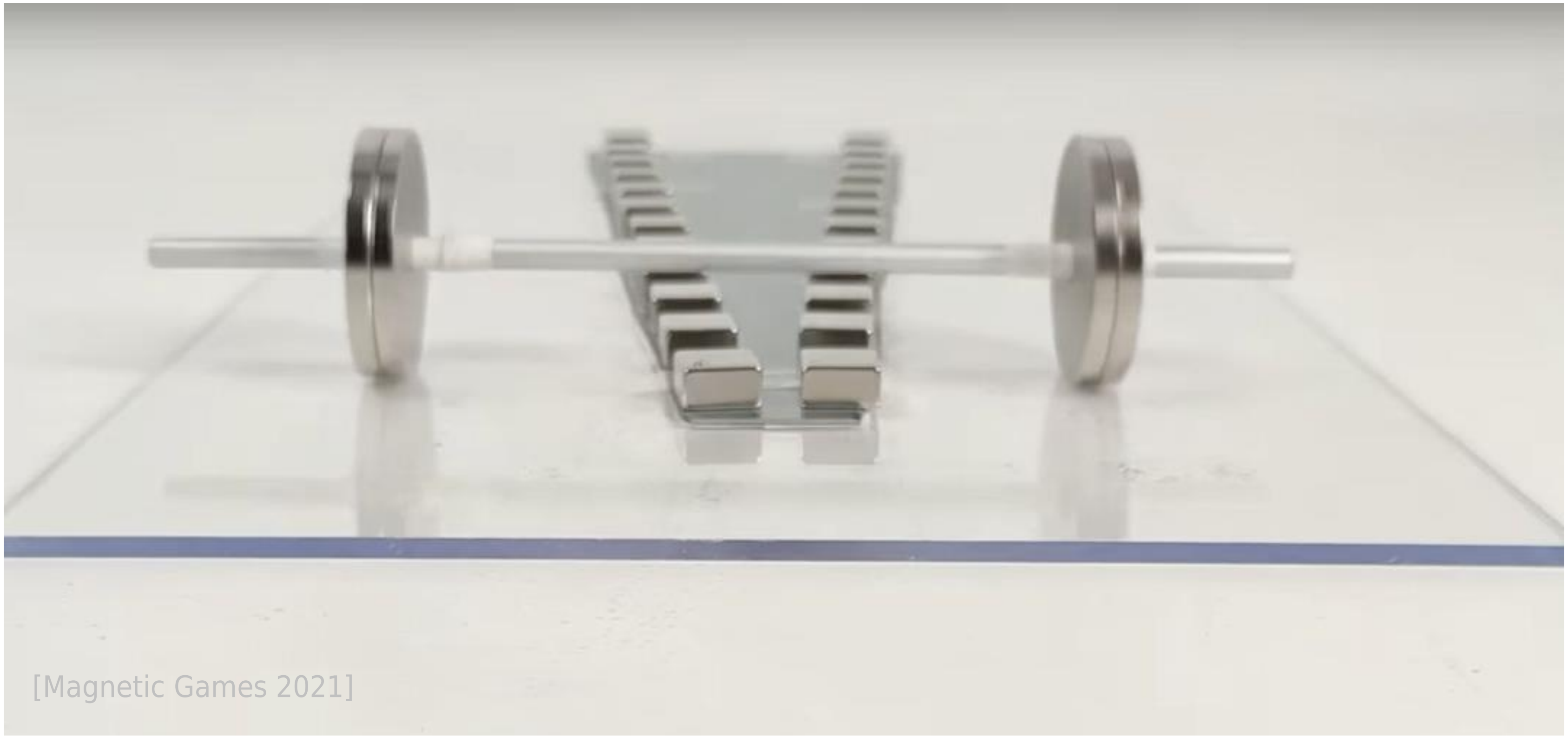

Problem No. 8 “Magnetic accelerator”

Fix magnets in pairs onto a metal sheet as shown. If you attach two magnetic discs onto an axle this "vehicle" will accelerate over the rows of magnets under certain conditions. Investigate the phenomenon.

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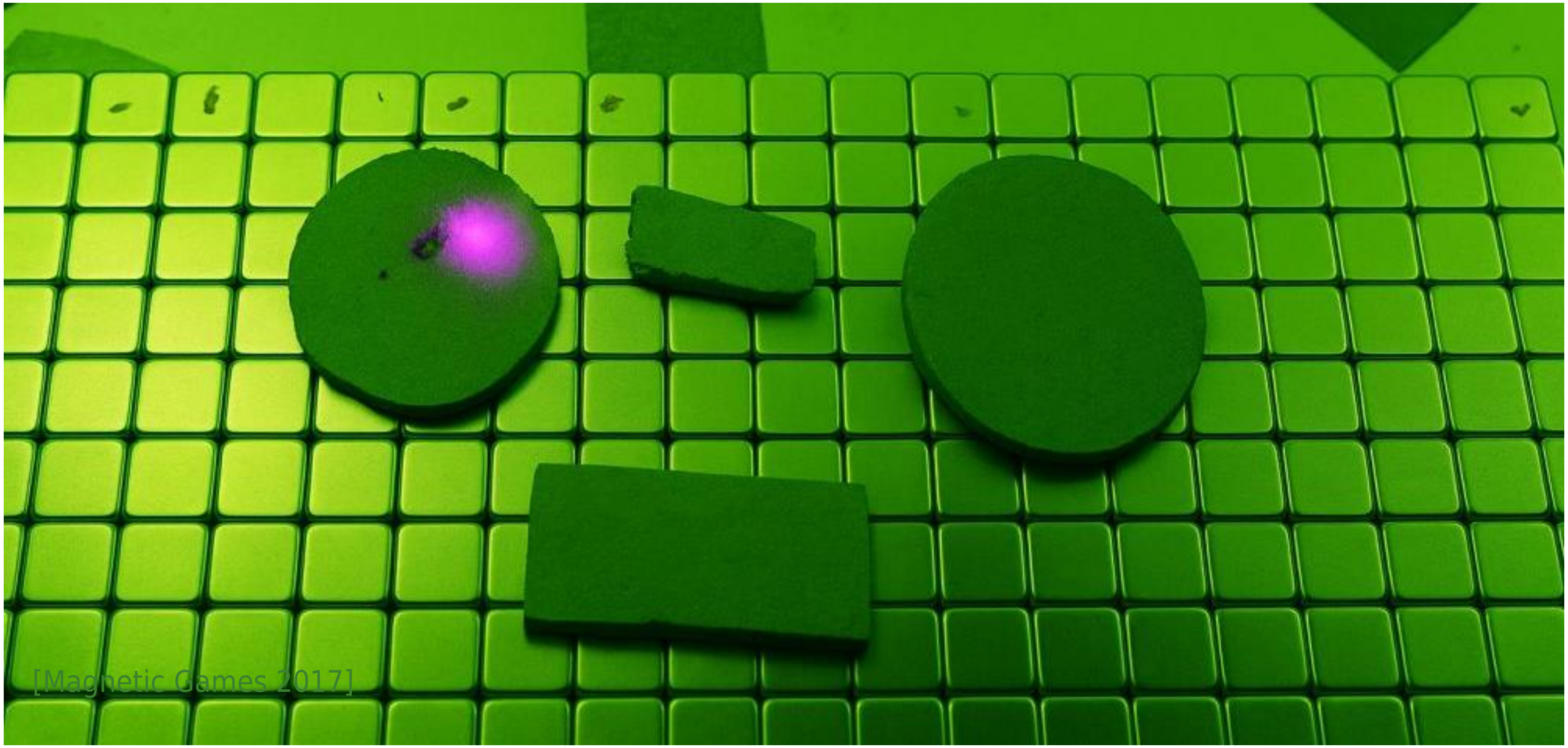

Problem No. 9 “Levitation control”

When arranged in a specific configuration, small graphite sheets can levitate on neodymium magnets. By shining light onto the surface of the graphite sheet, it is possible to control its movement. Explain and investigate the phenomenon.

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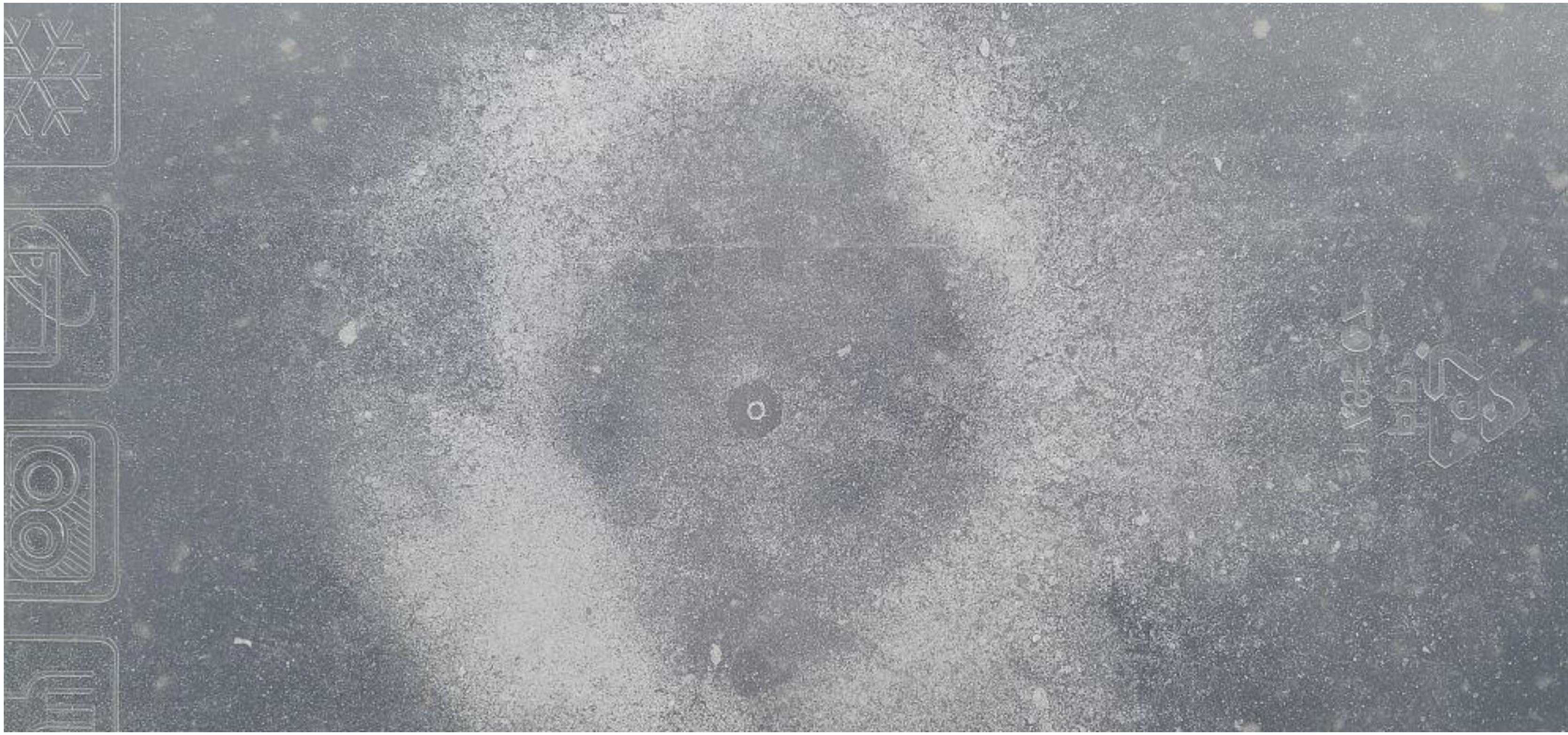

Problem No. 10 “Submerged crater”

If you release sand or similar granular material in a container filled with water, the material will sink to the bottom and may form a crater-like structure. Explain and investigate the phenomenon.

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Problem No. 11 “Sweet monochromator”

Pass linearly polarised white light through a column of sugar solution. When transmitted light is observed through a polariser it may appear coloured. Rotate the polariser, and the transmitted light colour may change. Construct such a sweet monochromator and optimise for the narrowest light wavelength bandwidth.

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Problem No. 12 “Autumn coin”

The motion of a coin falling to the bottom of a tank filled with liquid can be remarkably similar to the fluttering and tumbling of a falling autumn leaf. Investigate how the motion of the coin depends on relevant parameters.

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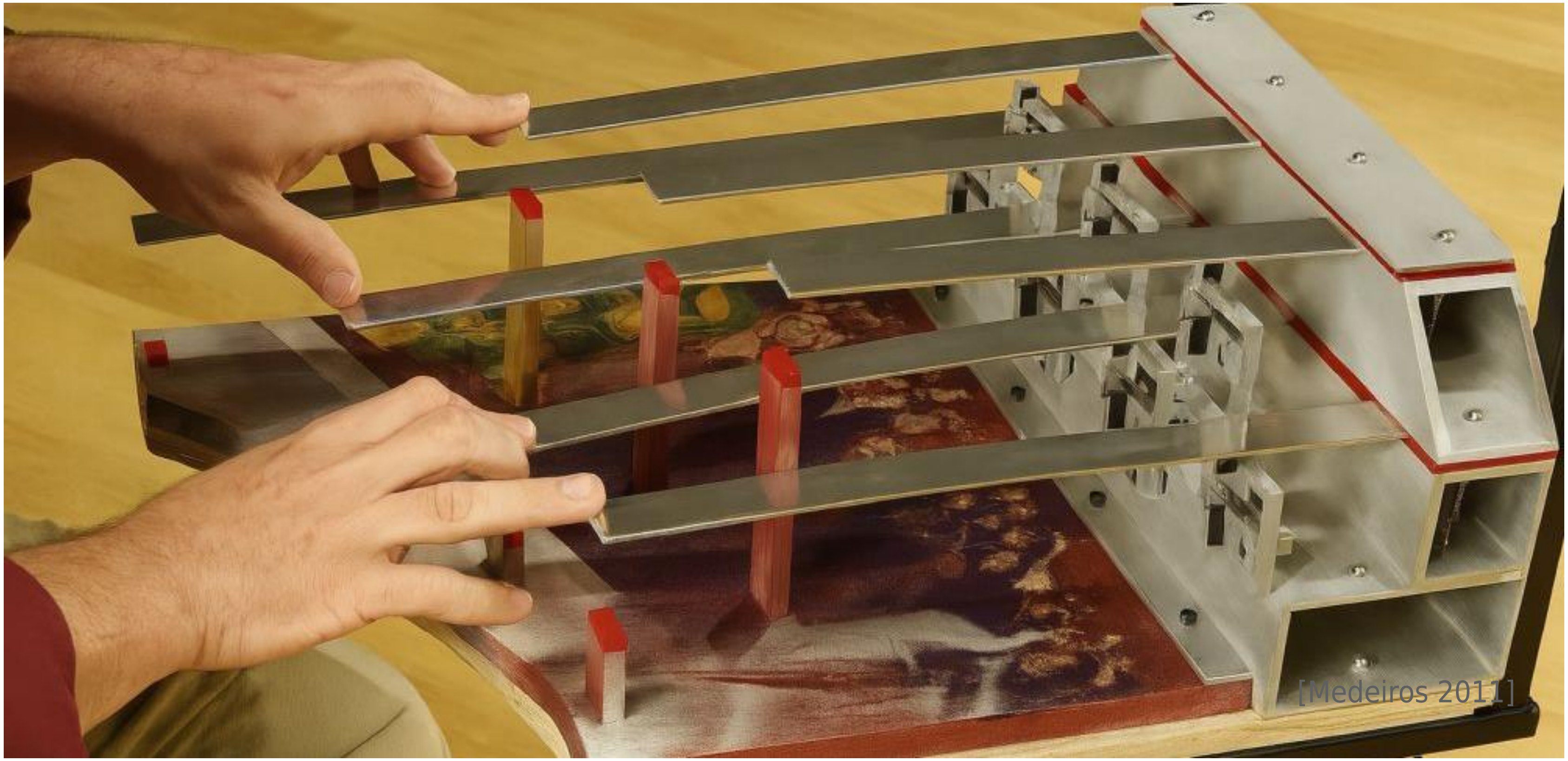

Problem No. 13 “The singing ruler”

When a ruler is clamped at one end and struck, it oscillates and emits a characteristic sound. Investigate how the sound depends on relevant parameters.

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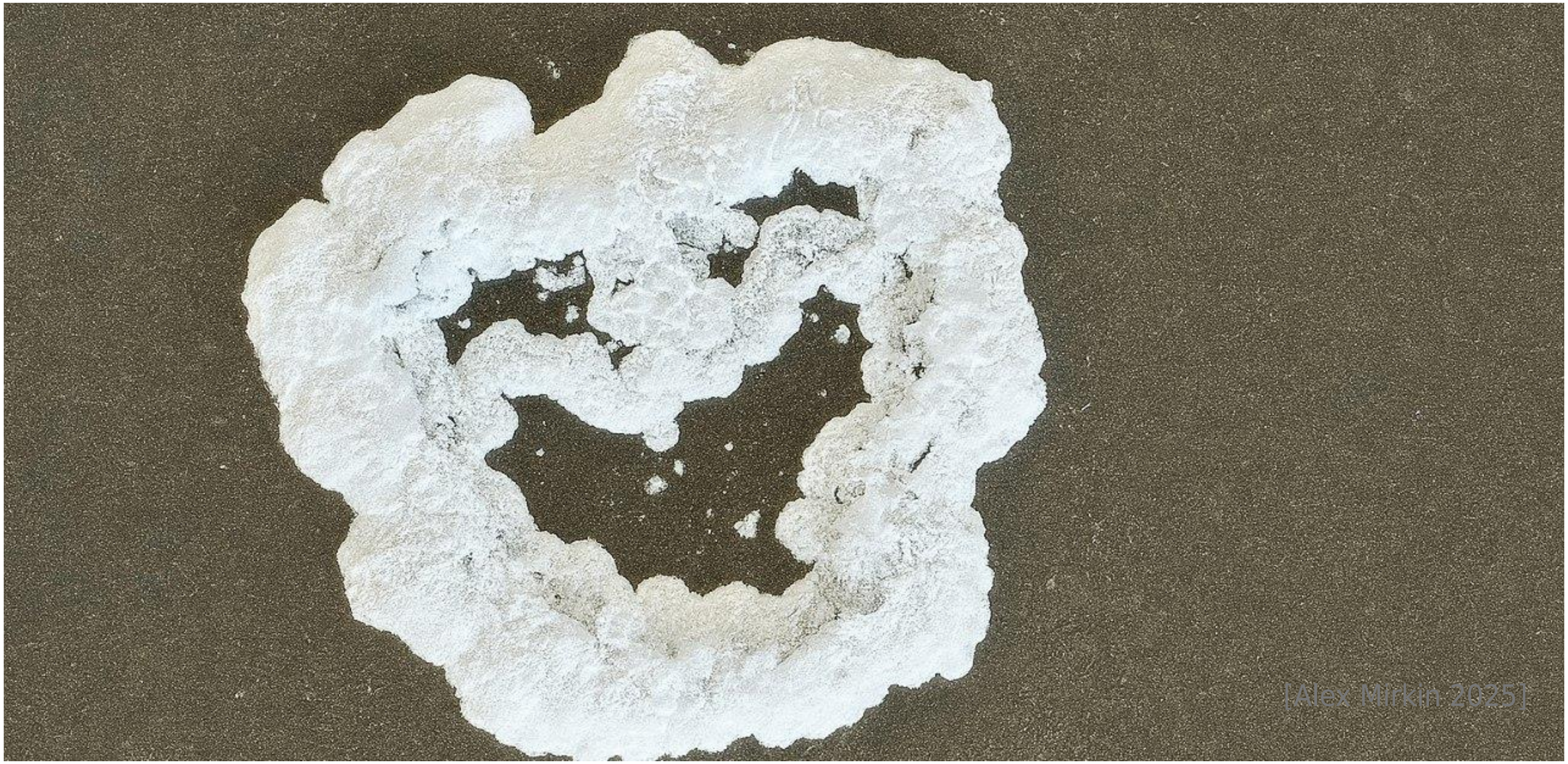


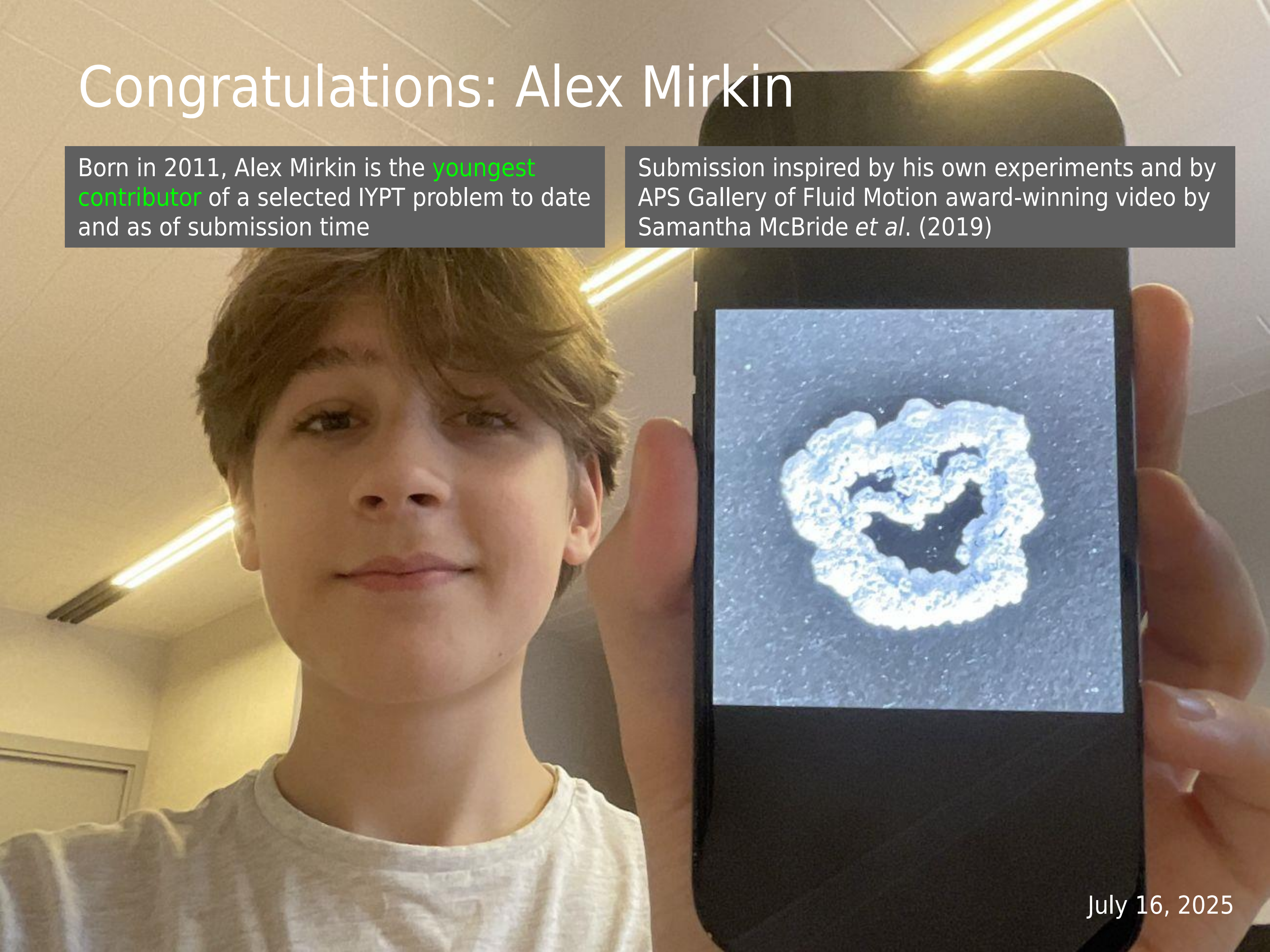
Problem No. 14 “Crystal critters”

Observe the evaporation of a drop of table salt solution on a warm hydrophobic surface. After the water evaporates, a variety of characteristic crystal shapes remain. Research and explain this phenomenon.

Congratulations: Alex Mirkin

Born in 2011, Alex Mirkin is the youngest contributor of a selected IYPT problem to date and as of submission time

Submission inspired by his own experiments and by APS Gallery of Fluid Motion award-winning video by Samantha McBride *et al*. (2019)



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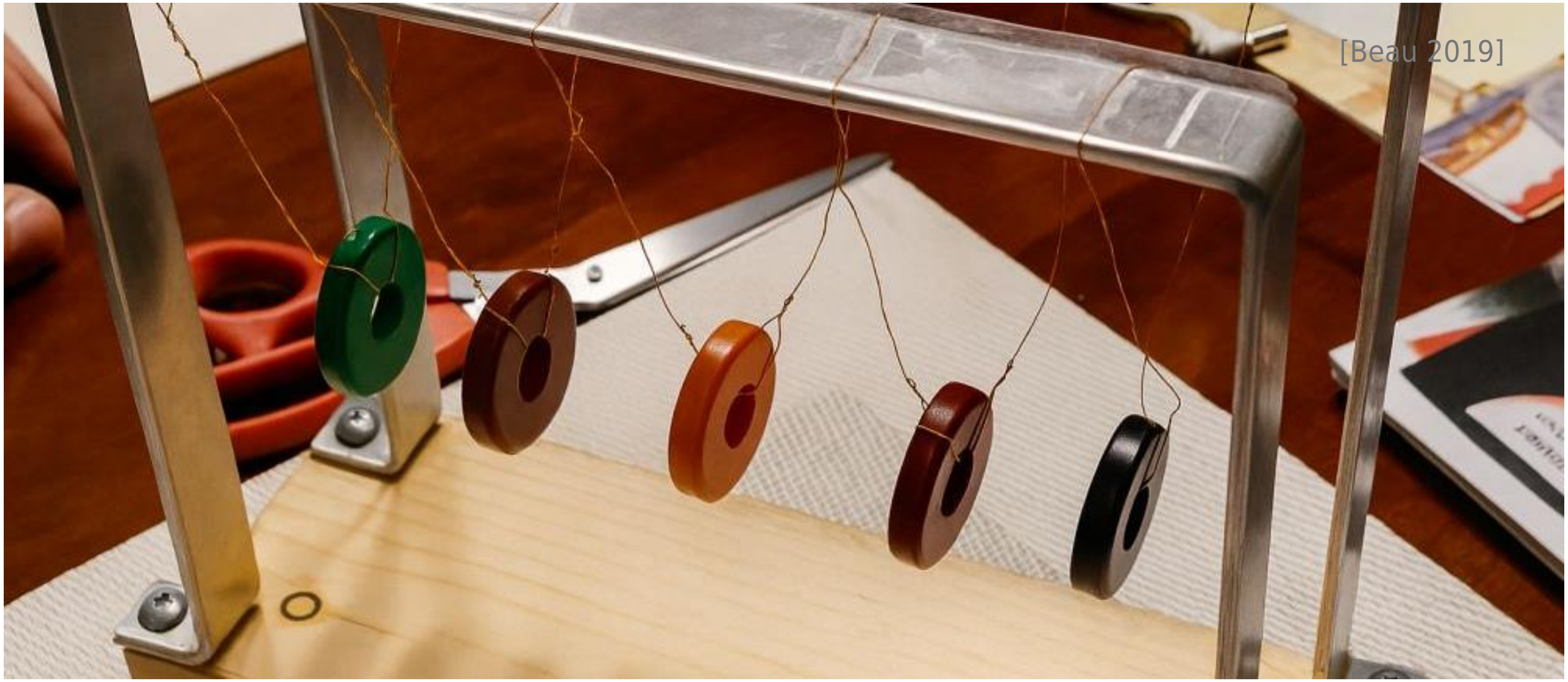

Problem No. 15 “Magnetic Newton’s cradle”

Repulsing, non-touching magnets are used instead of colliding balls to make a new type of Newton's cradle. The new cradle can act in a similar way to a regular cradle, but can also exhibit other interesting behaviour. Explain and study the movement of this magnetic cradle.

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Problem No. 16 “Twisted spaghetti”

When a bundle of spaghetti is twisted, it might withstand higher transverse (side) forces than a straight, untwisted bundle. Investigate the response of a twisted bundle to transverse stress and identify the optimal twist that maximises tolerance to transverse stress.

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Problem No. 17 “Travelling flame”

A flame can propagate continuously around a ringshaped trough containing a thin layer of flammable liquid. Investigate how the characteristics of this travelling flame depend on relevant parameters.

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Background reading

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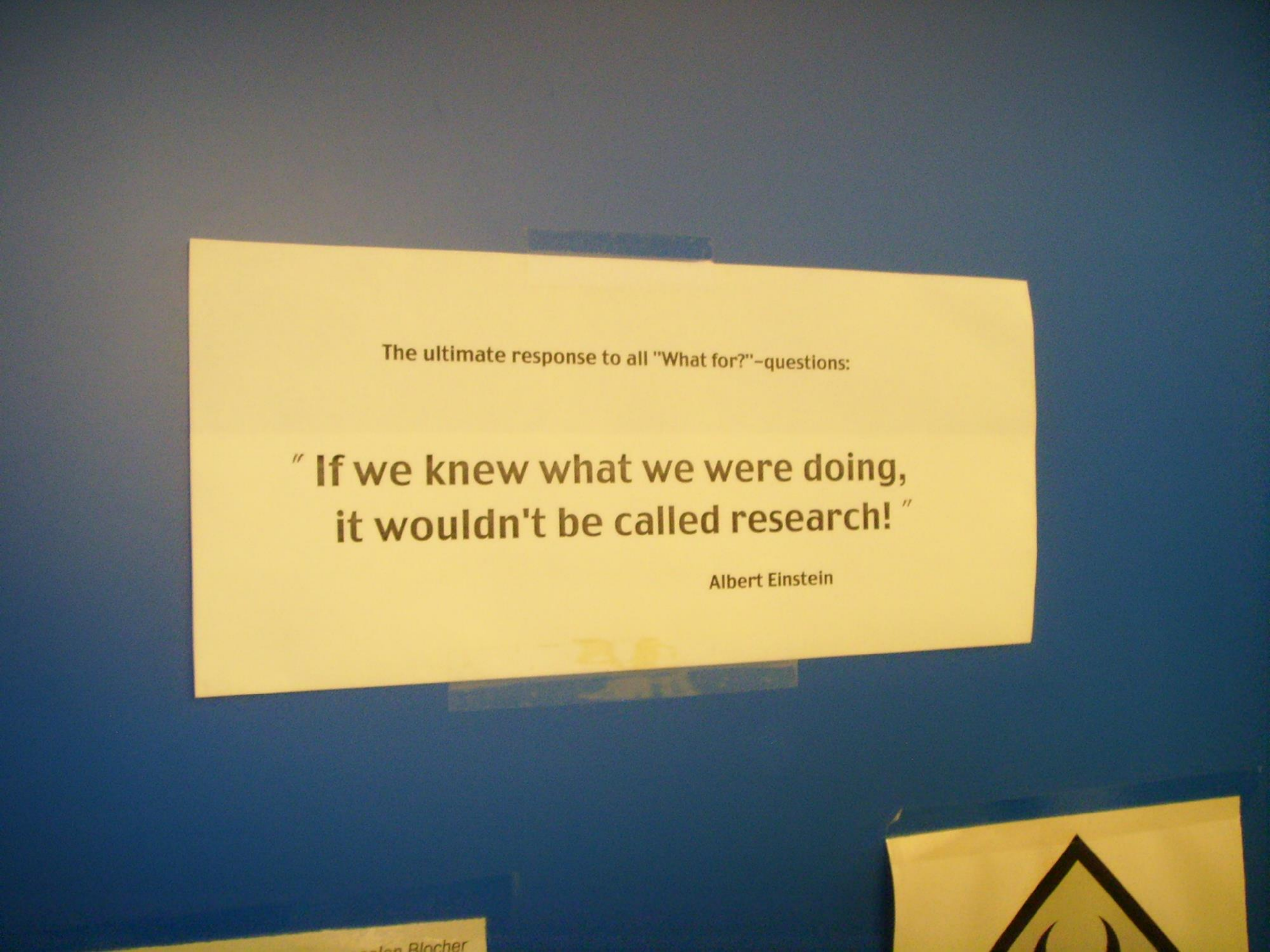

The ultimate response to all "What for?"–questions:
" If we knew what we were doing,
it wouldn't be called research! "
Albert Einstein

Habits and customs

- Originality and independence of your work is always considered as of a first priority
- There is no “correct answer” to any of the IYPT problems
- Having a deep background knowledge about earlier work is a must
- Taking ideas without citing is a serious misconduct
- Critically distinguishing between personal contribution and common knowledge is likely to be appreciated
- Reading more in a non-native language may be very helpful
- Local libraries and institutions can always help in getting access to paid articles in journals, books, and databases
- The IYPT is not about reinventing the wheel, or innovating, creating, discovering, and being able to contrast own work with earlier knowledge and the achievements of others?
- Is IYPT all about competing, or about developing professional personal standards?

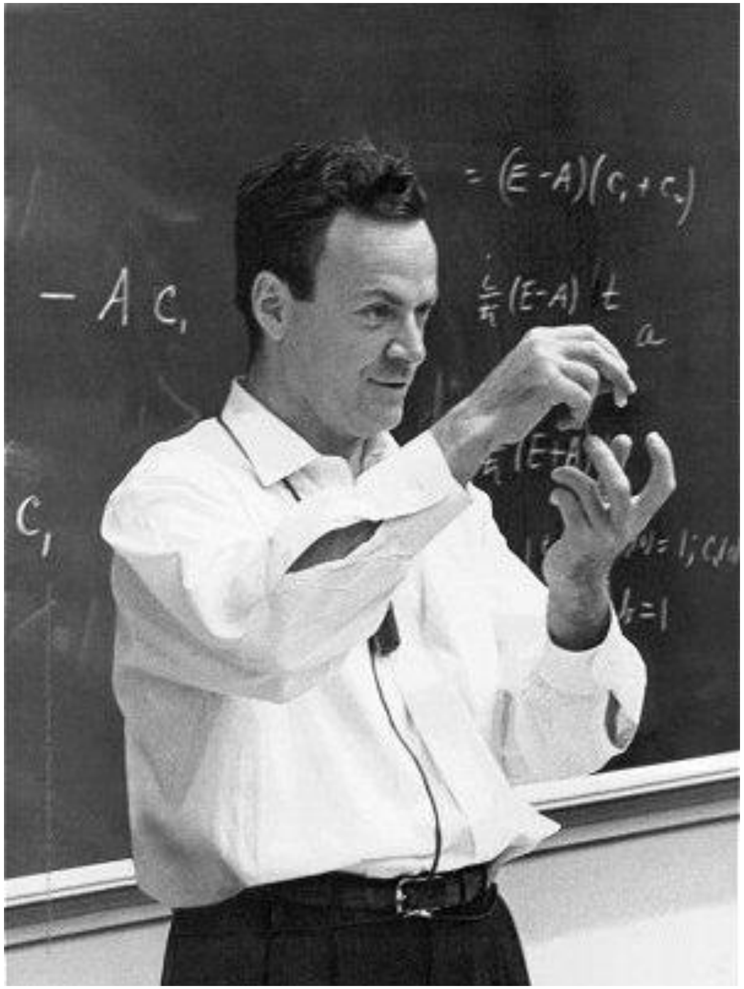
Requirements for a successful IYPT report

- Novel research, not a survey or a compilation of known facts
- Balance between experimental investigation and theoretical analysis
- Comprehensible, logical and interesting presentation, not a detailed description of everything-you-have-performed-and-thought-about
- Clear understanding of the validity of your experiments, and how exactly you analyzed the obtained data
- Clear understanding of what physical model is used, and why it is considered appropriate
- Clear understanding of what your theory relies upon, and in what limits it may be applied
- Comparison of your theory with your experiments
- Clear conclusions and clear answers to the raised questions, especially those in the task
- Clear understanding of what is your novel contribution, in comparison to previous studies
- Solid knowledge of relevant physics
- Proofread nice-looking slides
- An unexpected trick, such as a demonstration *in situ*, will always be a plus

Feynman: to be self-confident?

- “I’ve very often made mistakes in my physics by thinking the theory isn’t as good as it really is, thinking that there are lots of complications that are going to spoil it

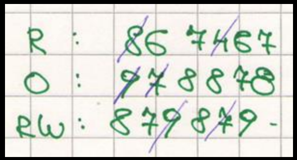
- — an attitude that anything can happen, in spite of what you’re pretty sure should happen.”



R.P. Feynman. Surely You’re Joking, Mr. Feynman (Norton, New York, NY, 1985)

In search for missing results

- Have you attended an IYPT marked in **red** and preserved Physics Fight results, e.g. by keeping printed rankings?
- Have you attended an IYPT marked in **orange** or **red**, and recorded grades from a Fight, e.g. by writing them down?



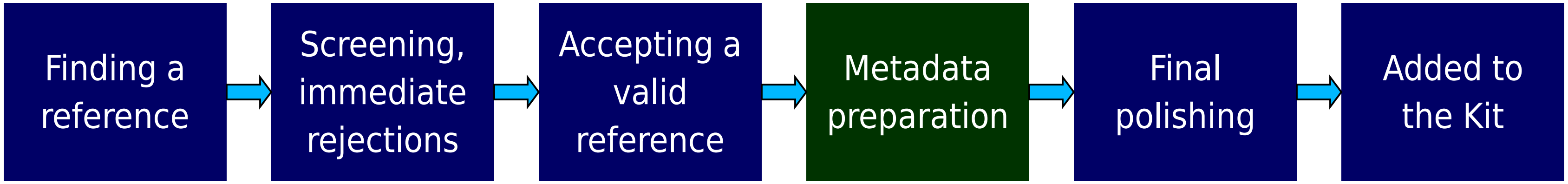
Green: each and every Juror's grade has been preserved
Orange: all Sums of Points (SP) are known, but some Juror's grades are not
Red: some Sums of Points (SP) are missing

								1988	1989
1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
2020	2021	2022	2023	2024	2025				

Thank you for helping us locate the missing results of past IYPTs

Expediting metadata extraction for the Kit

- **Each Kit includes extensive metadata for each reference as plain text**
  - Human-readable, comprehensible references (not just URL or DOI) to facilitate review and study
  - A well-documented reference will remain (more) usable in the future even if an exact URL goes dead



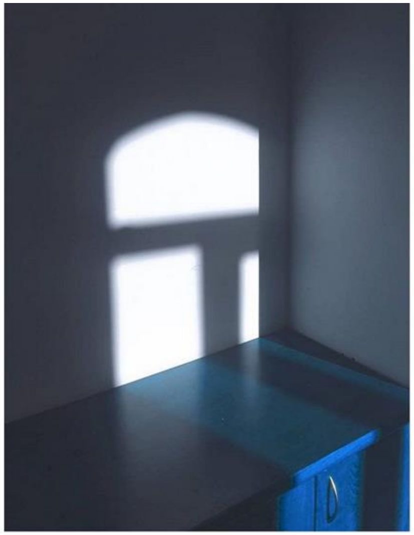
- Fetching metadata (e.g. publication dates for YouTube videos) is time consuming
  - However it must be done to keep the Kit usable and consistent now and in the remote future

- We acknowledge Sergey Bulykin and Artem Golomolzin for a custom-designed script that contributes to expedited metadata extraction
- Publication date, title, author etc. is retrieved automatically via API, in particular from YouTube, CrossRef, Semantic Scholar
- If the information cannot be found via API, a large language model (LLM) extracts details directly from the contents of the link

Call for cooperation

- If you are interested in the idea behind the Kit — to structure the existing knowledge about the physics behind the problems and to encourage students to contrast their personal contribution from the existing knowledge — your cooperation is welcome
- If more contributors join the work on the Kit for 2026, or plan bringing together the Kit for 2027, **good editions may be completed earlier**
- It would be of benefit for everybody,
  - students and team leaders, who would have an early reference (providing a first impetus to the work) and a strong warning that IYPT is all about appropriate, novel research, and not about “re-inventing the wheel”
  - jurors, who would have a brief, informal supporting material, possibly making them more objective about the presentations
  - the audience outside the IYPT, who benefits from the structured references in e.g. physics popularization activities and physics teaching
  - the IYPT, as a community and a center of competence, that may generate original, state-of-the-art research problems, widely used in other activities and at other events
  - and also the authors of the Kit, who could rapidly acquire a competence for the future activities and have a great learning experience

July 17, 2025
Aperture value F/2.8, exposure time 1/2 s, ISO 100
Focal length 9.7 mm (equivalent to 45 mm full frame)



Preparation to 39th IYPT' 2026: references, questions and advices

Photos by Alexey Cheremisin used on the cover with kind permission

Ilya Martchenko, [1] * Nikita Chernikov, [2]
Aleksandr Zinkevich, [2] and Anastasiya Litvinova [2]

[1] Foundation for Youth Tournaments
[2] Novosibirsk State University

July 7, 2025...July 18, 2025

* http://kit.ilyam.org